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(19) (CA) APPLICATION FOR CANADIAN PATENT (12)

(54) Elastomer Emulsions Used as Dust Control Additives in Anti-Skid Compositions

(72) Chung, Daniel K. - Canada ;

(73) Nalco Chemical Company - U.S.A. ;

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ABSTRACT OF THE DISCLOSURE

An anti-skid composition for use on cellulosic fibrous material which comprises water, colloidal silica and a water-based elastomer emulsion. The colloidal silica has a mean particle size in the range from about 10 to about 150 nm. The water-based elastomer emulsion is a film-forming rubber polymer resistant to heat, light and ozone, such as an elastomeric terpolymer. The colloidal silica is present in the anti-skid composition in the range between about 5 to about 50% by weight, based on the total weight of the anti-skid composition. The elastomer is present in the anti-skid composition in the range between about 0.1 to about 5%, as active material.

ELASTOMER EMULSIONS USED AS DUST CONTROL ADDITIVES IN ANTI-SKID COMPOSITIONS

The present invention relates generally to a unique anti-skid composition which includes a colloidal silica and a water-based elastomer emulsion. This anti-skid composition is particularly effective in controlling dust produced during treatment of cellulosic fibers in alkaline papermaking processes, especially when higher dosages of the anti-skid composition are required to maintain a satisfactory slide angle. It is particularly useful in imparting anti-skid properties to linerboard, fine paper and newsprint.

BACKGROUND OF THE INVENTION

Paper articles fabricated from Kraft paper, cardboard and other types of cellulosic fiber material have a tendency to slip and slide against each other, especially during transporting or stocking. This tendency is undesirable and in many cases harmful.

Various attempts have been made to overcome this slipping and sliding problem. For example, containers fabricated from crepe paper or containers treated with a form of an adhesive have been employed. Such containers have not been entirely satisfactory for reasons including

economy, poor printing characteristics, insufficient slip resistance, unpleasant or uncomfortable handling characteristics, cleanability factors and excessive amount of material required.

The problems of slipping and sliding are exacerbated when recycled fiber is used in the cellulosic material. As a consequence of extra processing, when compared with virgin fiber, the fiber length of the recycled material is less than that of the virgin fiber. The tendency to slip and slide increases as the amount of recycled fiber increases. In recent years there has been a tendency to increase the proportion of recycled fiber in cellulosic material, so that the problem of slipping and sliding is increased.

Furthermore, the use of recycled fiber in the finished paper has led to increasing problems in the handling of the paper, both in the mill and at converters, because of its increased slipperiness. This loss in the coefficient of friction is due to the shorter fibers, as well as from contaminants introduced with the recycled paper. These contaminants include dirt, wax, cold and hot melt adhesives, water proofing, and other special coatings, etc.

The problem of slipping and sliding has also been overcome by coating the cellulosic fibrous material with an

anti-skid product, such as colloidal silica. See Charles C. Payne, "Coating Paper with Colloidal Silicas Helps Stop Slippage of Containers," Pulp & Paper, August 1989, pp. 90-91. The colloidal silica is normally applied just before the takeup reel on a paper machine to take advantage of the "reel building" properties of the product. Without silica, telescoping effects often occur at that point.

The colloidal silica is typically applied by any of a number of conventional application methods. In lower speed machines, a water box application has been successfully used. In high speed machines, the colloidal silica has been applied as a surface coating by the "size" press in the paper mill. More commonly, however, a series of low pressure sprays apply the material to the sheet as it is being wound on its final reel.

Slide angles in paper products are preferably above 20°. This slide angle can be determined by positioning two paper surfaces (i.e., boxes coated with colloidal silica) one on top of the other, such that colloidal silica particles from one surface rub against particles on the second surface and create friction. Sideways force is required to cause the two boxes to slide against each other. If the two boxes are placed on an inclined plane, the angle where the two surfaces slide against each other is the "slide angle" or "coefficient of friction". The coefficient

of friction is equal to the tangent of the slide angle. Surface treatment with colloidal silica increases the static friction of linerboard.

Slide angles of less than 20° are the cause of several paper handling problems. First, in the paper mill itself it may be difficult to rewind the sheet as it would tend to wander along the reel. Additionally, when clamp trucks attempt to lift finished rolls of paper for shipping, the center of the reel may telescope out.

Slide angle retention with repeated slides is an important and practical factor of anti-skid material. To be effective, the coating of colloidal silica must remain on the surface. Total removal or loss of the silica particles reduces effectiveness against slippage, resulting in increased breakage of packaged goods. Conversely, problems have arisen when the colloidal silica adheres to strongly to machinery, application equipment, floor surfaces, etc. when overspray occurs. Recently, commercial colloidal silica sol products containing urea have appeared on the market. (See Canadian Patent No. 1,156,803 (Carstens)). Those materials tend to eliminate this adherence problem in the formation of a water washable material.

The use of urea with an aqueous sol or suspension of colloidal silica provides a dual benefit in achieving better

slide angles. First, the presence of urea provides the surface of a material coated with the anti-skid composition with a more permanent and constant coefficient of friction. Secondly, the urea serves to "blind" or "encapsulate" wax particles which accompany recycled paper and contribute to its slipperiness.

Although ability to impart a high slide angle and washability are important, there are other desirable characteristics of an anti-skid composition. It should be stable over a period of at least several weeks at temperatures up to 50°C or higher. It should also be non-dusting. The magnitude of any dusting problem depends to some extent on the speed at which machinery handling the cellulosic material operates; the faster the machine operates the greater its tendency to throw dust in the air. Hence, as machine speeds increase this problem also increases.

One attempt at satisfying all of the requirements for an anti-skid composition, i.e., washability, slide angle, stability and dust control, is set forth in U.S. Patent Application, Serial No. 07/493,120, filed March 15, 1990. This application provides an anti-skid composition for use on cellulosic fibrous material which comprises water, colloidal silica having a particle size in the range 10 to 150nm, a water soluble acrylamide polymer and, preferably, a

compatible amphoteric, anionic or nonionic surfactant. This anti-skid composition is applied to the cellulosic fibrous material in a known manner. For example, when applied to linerboard the composition may be added to water sprayed from a spray bar onto a roll which is part of the machine on which the linerboard is formed. The amount of the composition added to the water is usually about 5% by volume. In a typical machine this may require supply of the anti-skid composition at a rate of about 135 to 140 mL/min.

In non-alkaline papermaking processes, the use of the aforementioned anti-skid composition comprising water, colloidal silica having a particle size in the range 10 to 150nm and a water soluble acrylamide polymer, and rosin size provides satisfactory anti-skid results. However, many papermaking processes have been converted to alkaline processes and the rosin replaced with an alkyl ketene dimer sizing. Unfortunately, these alkaline papermaking processes have been experiencing increased slipperiness in their paper products. The anti-skid composition of colloidal silica and crosslinked polyacrylamide binder did not provide sufficient performance, as it reached a performance plateau far sooner than the requirements demand. Another drawback of the colloidal silica and crosslinked polyacrylamide anti-skid composition was the increased dusting generated at higher dosages. It was believed that maybe the crosslinked polyacrylamide did not have enough binding force for the

colloidal silica. Attempts at adding more crosslinked polyacrylamide binder resulted in a destabilized product.

The present invention provides a unique anti-skid composition which is capable of meeting all slide angle, washability, stability and dust control performance requirements when added to an alkaline paper product, especially linerboard, fine paper or newsprint. Moreover, the unique dust control additive of the present invention permits substantial increases to the feed rate of the anti-skid composition without dusting.

The present invention also provides many additional advantages which shall become apparent as described below.

SUMMARY OF THE INVENTION

An anti-skid composition for use on cellulosic fibrous material. The anti-skid composition includes water, colloidal silica and a water-based elastomer emulsion. It is particularly useful in overcoming slipperiness and dusting problems associated with the production of alkaline paper products, e.g., linerboard, fine paper and newsprint.

The colloidal silica used in this anti-skid composition typically has a mean particle size in the range from about 10 to about 150 nm. One preferred colloidal silica has a

particle size in the range from about 15 to about 25 nm, a pH in the range from about 8.0 to about 9.5, a surface area in the range from about 120 to about 176 m^2/gram, and a viscosity at 77°F of less than about 70 centipoise.

The water-based elastomer emulsion is preferably a film-forming rubber polymer resistant to heat, light and ozone, e.g. an elastomeric terpolymer. A preferred elastomeric terpolymer has 50.5% total solids, pH of 8.4, surface tension of 40 dynes/cm, Brookfield viscosity of 200 centipoise, and a particle size of 0.2 microns.

Another object of the present invention is an article comprising a substrate having adhered to at least one surface thereof an effective amount of anti-skid composition according to the present invention.

Still another object of the present invention is a process for improving the anti-skid properties of cellulosic fibrous material, as determined by the slide angle, which process comprises applying to the cellulosic fibrous material an anti-skid composition which comprises water, colloidal silica and a water-based elastomer emulsion; whereby the dusting tendency of the colloidal silica during application is satisfactorily controlled.

The anti-skid composition according to the present invention is particularly effecting in controlling dust and slipperiness when used to treat alkaline cellulosic fibrous material comprising alkyl ketene dimer sizing.

Other and further objects, advantages and features of the present invention will be understood by reference to the following specification.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The use of a low cost elastomer emulsion as a binding agent in the anti-skid composition according to the present invention is extremely effective in controlling the dusting tendency of the colloidal silica also contained therein, especially in alkaline papermaking processes. It has also proved to be effective in preventing slipperiness in the resultant paper product which can have a slide angle of 28° and above.

The water-based elastomer emulsion may be combined with a colloidal silica in any convenient manner. Thus, the elastomer emulsion may be combined with the colloidal silica and the concentrations of the components adjusted by proper dilution with water. The normal anti-skid treatment employed by many paper mills consists of spraying a dilute

dispersion of colloidal silica on the surface of the paper product.

The anti-skid composition according to the present invention and used on cellulosic fibrous material comprises water, colloidal silica and a water-based elastomer emulsion. While various combinations of colloidal silica and water-based elastomer emulsion have proved suitable, it has been found that a ratio of colloidal silica to elastomer emulsion of about 40 to 1 is most effective.

The anti-skid composition preferably has a pH value in the range between about 7 to 10, more preferably in the range between about 8.5 to 9.5.

When applied to linerboard the anti-skid composition may be added to water sprayed from a spray bar onto a roll which is part of the machine on which the linerboard is formed. The amount of the composition added to the water is usually about 5% by volume. In a typical machine this may require supply of the anti-skid composition at a rate of about 135 to 140 mL/min. However, in alkaline papermaking processes this rate may be substantially increased to approximately 380 mL/min. The quantity can of course be metered and varied in accordance with need.

COLLOIDAL SILICA

The mean particle size of the colloidal silica should fall within the range of about 10 to about 150 nm. An example of a suitable colloidal silica used herein is one having a particle size in the range from about 15 to about 25 nm, a pH in the range from about 8.0 to about 9.5, a surface area in the range from about 120 to about 176 m^2/gram, and a viscosity at 77°F of less than about 70 centipoise.

The colloidal silica is typically present in the range of approximately 5 to 50% by weight, based on the total weight of the anti-skid composition. Preferably, the colloidal silica should be present in concentrations of approximately 30 to 50% by weight, based on the total weight of the composition. However, the precise concentration of colloidal silica can be varied on an ever wider scale depending upon particular application methods and conditions within the skill of the artisan.

WATER-BASED ELASTOMER EMULSION

The water-based elastomer emulsion is typically a film-forming rubber polymer resistant to heat, light and ozone, e.g., an elastomeric terpolymer sold under the trademark HyStretch™ V-43 by The B.F. Goodrich Company. The HyStretch™ latex V-43 is an elastomeric terpolymer having 50.5% total solids, pH of 8.4, surface tension of 40

dynes/cm, Brookfield viscosity of 200 centipoise, and a particle size of 0.2 microns. HyStretch^{TM} elastomer emulsions are sprayable, foamable and heat sensitizable.

The elastomer is preferably present in the anti-skid composition in the range between about 0.1 to about 5%, as active material. Concentrations above 5% tended to reduce the slide angle of the paper product.

This anti-skid composition is preferably adhered to at least one surface of an article comprising a substrate. The substrate is typically a paper product such as linerboard, fine paper, or newsprint. The substrate may be formed from either virgin fibers, recycled fibers or any combination thereof.

The anti-skid composition of the present invention is particularly useful for improving the anti-skid properties of cellulosic fibrous material, as determined by the slide angle, which process comprises applying to the cellulosic fibrous material the anti-skid composition which comprises water, colloidal silica and a water-based elastomer emulsion; whereby the dusting tendency of the colloidal silica during application is satisfactorily controlled. Although this anti-skid composition improves the anti-skid properties and controls dusting in conventional papermaking processes, it is particularly effective when used to treat

alkaline cellulosic fibrous material comprising an alkyl ketene dimer sizing.

This anti-skid composition is typically added to the alkaline cellulosic fibrous material in a dosage within the range between about 300 to about 380 mL/min, and to non-alkaline cellulosic fibrous material in a dosage within the range between about 135 to about 140 mL/min.

The properties and effectiveness of the anti-skid composition in controlling dust and slipperiness in the manufacturing of linerboard, fine paper and newsprint is clearly demonstrated in the below examples. Also set forth below is comparative data demonstrating the increased effectiveness of the anti-skid composition verses conventional compositions in treating alkaline paper products.

EXAMPLE 1

The test procedures for determining slide angle involve dipping suitable dimensioned strips of mill paperboard into a one-day old 5% solution of formulated product, i.e., alkyl ketene dimer (AKD) size, solution. The lightly wetted papers were then sandwiched by two blotter papers and dried by a drum dryer.

Anti-skid compositions with various formulations were prepared as 5% solutions. Thereafter, the AKD-coated papers were treated in the same manner as above with these anti-skid compositions. The colloidal silica used in samples 3-6 had a particle size of about 20 nm, a pH of about 8.5, a surface area of about 150 m^2/gram, and a viscosity at 77°F of about 15 centipoise. The elastomer in samples 4-6 was an elastomeric terpolymer having 50.5% total solids, pH of 8.4, surface tension of 40 dynes/cm, Brookfield viscosity of 200 centipoise, and a particle size of 0.2 microns sold under the trademark HyStretch™ V-43 by The B.F. Goodrich Company.

Samples of the treated paper were then mounted on an adjustable plane wherein an inclined plane test following ASTM procedure D3248-73 was used to determine the angle where two surfaces slide together. Three slide angle measurements are taken, i.e., right side, middle and left side. The important criterion is the level of angle achieved and the degree of change between the first and third measurement of any one sample. The results of this experiment are set forth below in Table 1.

TABLE 1

		Slide Angles		
Sample	Anti-Skid Composition	Right	Middle	Left
1	Blank	21°	22°	22°
2	C.S.*/Urea	29°	24°	24°
3	C.S.**	30°	29°	29°

4	C.S.**/1% Elastomer	30°	30°	30°
5	C.S.**/2% Elastomer	33°	33°	33°
6	C.S./2% Elast./2% Glycol***	28°	27°	27°

* C.S. denotes a colloidal silica.

** C.S. denotes a colloidal silica having a mean particle size of about 20.

*** The 2% Glycol is a propylene glycol.

The sample of colloidal silica and 2% elastomer emulsion not only gave the highest slide angle but also exhibited no sign of rubbing off the colloidal silica (i.e., dusting) from the paper surface.

EXAMPLE 2

An alkaline papermaking mill was evaluated using various anti-skid compositions to determine their effect on slide angle and dusting. Paper produced from this mill without any treatment with an anti-skid composition demonstrated a slide angle of from about 11° to about 18°.

When an anti-skid composition having colloidal silica with a mean particle size of about 20 nm was used to treat the paper product at a dosage of about 240 mL/min. (i.e., 0.24kg/1000m^2) it produced a slide angle of about 23°. Since a 23° slide angle was determined by the mill operators to be unacceptably low, i.e., a slide angle of at least 28° is required to take care of base sheet variation, the feed rate was increased to 300 mL/min. At a feed rate of 300 mL/min., the colloidal silica solution was dusting moderately at the rewinder although no dust was evident at the lower feed rate of 240 mL/min. Because of the lower

active content of this colloidal silica, it was decided to increase the feed rate to 380 mL/min. which produced even greater dusting.

Upon addition of an anti-skid composition comprising colloidal silica, an elastomer emulsion and water, the dusting problem at the rewinder immediately disappeared. Fifty minutes later the above anti-skid composition was replaced with a composition comprising colloidal silica, an elastomer emulsion, water, and a fumed silica. The purpose of adding the fumed silica was to access whether the larger sized fumed silica would result in a higher slide angle. No appreciable dusting or change in slide angle was noted.

The results are set forth in Table 2 below:

TABLE 2

Product	Time	Dosage mL/min.	Slide Angle Front	Slide Angle Back	Slide Angle Rewinder	Observation
CS	09:52	240	33°	28°	23°	no dusting
CS	10:27	300	28°	34°	26°	dusting
CS	11:12	300	32°	30°	33°	dusting
CS/Elas.	12:20	380	22°	25°	31°	no dusting
CS/Elas/FS	12:52	380	25°	29°	30°	no dusting
CS	13:59	300	23°	--	--	dusting

Note: (1) CS denotes a colloidal silica having a mean particle size of approximately 20 nm.
(2) The elastomer emulsion was HyStretch™ V-43.
(3) FS denotes a fumed silica sold under the trademark Aerosil 200.

EXAMPLE 3

The following experiments set forth below in Table 3 demonstrate that the anti-skid composition according to the present invention also performs satisfactorily when used to treat fine paper.

TABLE 3

(SLIDE ANGLE TEST RESULTS)

Product	Slide Angle Right	Middle	Left	Sheet Average	Application (g/sqm)
Blank	17.4	18.3	18.3	17.9	no water
Blank	23.7	24.6	24.0	24.1	0.11 as water
CS/AA*	30.0	30.3	29.1	30.1	0.29
CS/AA*	29.5	27.2	28.1	28.3	0.25
CS/AA*	29.0	29.0	26.9	28.3	0.15
CS/AA*	27.5	29.5	31.7	28.5	0.08
CS (20nm)	27.2	32.0	32.7	30.6	0.34
CS (20nm)	30.3	32.2	31.7	31.4	0.21
CS (20nm)	28.5	28.0	28.0	28.4	0.16
CS (20nm)	27.5	28.5	26.3	27.4	0.06
CS/AA**	32.0	32.3	32.7	32.3	0.21
CS/AA**	31.3	32.3	32.8	32.1	0.27
CS/AA**	31.3	27.8	31.3	30.1	0.15
CS/AA**	29.7	29.0	[illegible]	[illegible]	[illegible]
CS/Elas.***	31.5	30.2	[illegible]	30.4	0.29
CS/Elas.***	32.0	31.2	29.0	30.7	0.25
CS/Elas.***	29.0	29.0	27.5	28.5	0.13
CS/Elas.***	27.0	28.2	27.5	27.6	0.08
CS/FS****	31.7	32.0	[illegible]	32.5	0.25
CS/FS****	32.8	31.8	[illegible]	33.1	0.29
CS/FS****	32.0	30.2	[illegible]	31.9	0.21
CS/FS****	32.0	32.0	[illegible]	30.5	0.10
CS/FS****	27.5	26.8	[illegible]	28.5	0.07

* This is a composition of colloidal silica having a mean particle size of 90nm and a crosslinked polyacrylamide nonionic solution polymer, 41% active.

** This is a composition of colloidal silica having a mean particle size of 20nm and a crosslinked polyacrylamide nonionic solution polymer, 49% active.

*** This is a composition of colloidal silica having a mean particle size of 20nm and an elastomer emulsion, 41% active.

**** This is a composition of colloidal silica having a mean particle size of 20nm and fumed silica, 41% active.

While I have shown and described several embodiments in accordance with my invention, it is to be clearly understood that the same are susceptible to numerous changes apparent to one skilled in the art. Therefore, I do not wish to be limited to the details shown and described but intend to show all changes and modifications which come within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. An anti-skid composition for use on cellulosic fibrous material which comprises water, colloidal silica and a water-based elastomer emulsion.

2. The anti-skid composition according to claim 1 wherein said colloidal silica has a mean particle size in the range from about 10 to about 150 nm.

3. The anti-skid composition according to claim 1 wherein said colloidal silica is present in the range of about 5 to 50% by weight, based on the total weight of said anti-skid composition.

4. The anti-skid composition according to claim 2 wherein said colloidal silica has a particle size in the range from about 15 to about 25 nm, a pH in the range from about 8.0 to about 9.5, a surface area in the range from about 120 to about 176 m^2/gram, and a viscosity at 77°F of less than about 70 centipoise.

5. The anti-skid composition according to claim 1 wherein said water-based elastomer emulsion is a film-forming rubber polymer resistant to heat, light and ozone.

6. The anti-skid composition according to claim 5 wherein said water-based elastomer emulsion comprises an elastomeric terpolymer.

7. The anti-skid composition according to claim 6 wherein said elastomeric terpolymer has 50.5% total solids, a pH of about 8.4, a surface tension of about 40 dynes/cm, a Brookfield viscosity of about 200 centipoise, and a particle size of about 0.2 microns.

8. The anti-skid composition according to claim 1 wherein the elastomer is present in said anti-skid composition in the range between about 0.1 to about 5%, as active material.

9. The anti-skid composition according to claim 1 wherein the ratio of said colloidal silica to said water-based elastomer emulsion is about 40 to 1.

10. An article comprising a substrate having adhered to at least one surface thereof an effective amount of an anti-skid composition which comprises water, colloidal silica and a water-based elastomer emulsion.

11. The article according to claim 10 wherein said substrate is a paper product such as linerboard, fine paper, or newsprint.

12. The article according to claim 10 wherein said substrate is a recycled paper product such as linerboard, fine paper or newsprint.

13. A process for improving the anti-skid properties of cellulosic fibrous material, as determined by the slide angle, which process comprises applying to said cellulosic fibrous material an anti-skid composition which comprises water, colloidal silica and a water-based elastomer emulsion; whereby the dusting tendency of said colloidal silica during application is satisfactorily controlled.

14. The process according to claim 13 wherein said cellulosic fibrous material is alkaline and includes a sizing material.

15. The process according to claim 13 wherein said cellulosic fibrous material is alkaline and includes an alkyl ketene dimer.

16. The process according to claim 14 or 15, wherein said anti-skid composition is added to said alkaline cellulosic fibrous material in a dosage within the range between about 300 to about 380 mL/min.

17. The process according to claim 14 or 15 wherein said alkaline cellulosic fibrous material comprises virgin fibers, recycled fibers or a combination thereof.

18. The process according to claim 14 or 15 wherein said alkaline cellulosic fibrous material is either linerboard, fine paper or newsprint.

SMART & BIGGAR
OTTAWA, CANADA

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